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PHYSICS.—*The specific heat of copper in the interval 0° to 50°C., with a note on vacuum-jacketed calorimeters.*[1] D. R. HARPER 3d, Bureau of Standards.

The determinations in the temperature range 0 to 100° are interpreted to indicate that the specific heat of copper (hard-drawn probably excepted) at 50° is between 0.0926 and 0.0931.

The specimen of copper was a long annealed wire (50 meters) 99.87 per cent pure, suspended in vacuo and connected as part of an electric circuit. A measured quantity of heat could thus be imparted to it electrically and the temperature rise found by using the specimen itself as a resistance thermometer. The test specimen was thus its own calorimeter, no other substance being included in the "water equivalent" with the single exception of a few grams of mica necessary for electrical insulation. To arrange a large enough amount of copper in a form suitable for the electrical measurements, the wire was coiled into spirals containing about 150 cm. each and 32 of these, superposed with mica plates between, built up a cylinder about 10 cm. by 10 cm. containing over 2 kgm. of copper and possessing an electrical resistance of about 0.2 ohm, sufficient to permit of making the necessary measurements with requisite accuracy.

Potential leads tapped in at a distance from the ends of the wire served to define a portion whose mass was that of copper involved in the determination. The resistance of this portion

[1] To appear in the Bulletin of the Bureau of Standards, 11, 1914.

was that which was comprehended in the thermometric factor, and the energy supplied to it during the period of heating was the product of the current in the coil by the potential drop between these leads, integrated over the time the heating circuit was closed. This potential drop was measured directly with a potentiometer and the current was measured with the same potentiometer balanced on the drop across a 0.1 ohm resistance standard connected in the series in the circuit. The time factor was obtained by automatic chronograph record of the instants when the heating current was switched on and off.

The specimen was heated 4° to 5° in each experiment, the rise in temperature being determined by the change of resistance of the specimen relative to the resistance of a 0.1 ohm manganin resistance standard immersed in an oil bath. The comparison was effected by a potentiometer, sensitive to about one part in five hundred thousand, and the current employed in making the comparison was small enough (about 0.3 amp.) that its heating effect on the specimen (about 0.001 per minute) could readily be allowed for without appreciable error.

To obtain the factor for the reduction of the increase in resistance to rise of temperature on the international hydrogen scale, the copper thermometer was compared at several temperatures with two standard platinum thermometers in a stirred oil-bath comparator.

By suspending the specimen in vacuo, the uncertainties in the cooling correction which occur at atmospheric pressure due to convection were avoided, the magnitude of the correction was increased, and uncertainty in the amount of air to be included in the water-equivalent (a source of error barely appreciable) was avoided. The efficacy of the vacuum jacket in reducing the magnitude of the cooling correction was by no means what was anticipated.

The results of 27 determinations at temperatures between 15° and 50° possess an average deviation of one part in a thousand millimeters from $0.383_4 + 0.00020$ (t-25) international joules per gram degree; equivalent to $0.0917 + 0.000048$ (t-25) calories_{20} per gram degree, if 4.182 joules equal one (20°) calorie.

PHYSICS.—*An experimental study of the Koepsel permeameter.* CHARLES W. BURROWS.[1] Bureau of Standards.

A detailed experimental study of the possibilities and limitations of the Koepsel permeameter has led to the following conclusions regarding the different factors which may affect the accuracy of the readings:

1. Readings on the two sides of the zero of the instrument may differ considerably but the mean of the two values thus obtained shows satisfactory consistency on repetition.
2. Shearing curves for different grades of material show that the correction to be applied to the observed magnetizing force is not constant for a given induction, but depends upon the nature of the test specimen. This correction is usually subtractive for points below the knee of the induction curve and additive for points above the knee.
3. An increase in the cross section of the test specimen tends to increase the observed values of the magnetizing force for points below the knee of the induction curve, and to decrease the observed values for points above the knee.
4. The length of the specimen projecting beyond the yokes produces no noticeable effect for points below the knee of the induction curve. For points above the knee the projecting ends increase the observed value of the magnetizing force.
5. If the bushings are not pushed all the way into their proper position, a higher apparent value of the magnetizing force is observed due to the increased length of the portion of the bar under test.
6. Hysteresis loops obtained by the Koepsel permeameter always show a low observed residual induction and a high observed coercive force.
7. A theoretical and experimental study of the distribution of the magnetic fluxes through different parts of the magnetic circuit shows that shearing curves of the form observed are to be expected.

Apparatus of this type if used without correction may yield data greatly in error. The results of the present study show that for small and moderate inductions the measured magnetizing force is usually in excess of its true value, sometimes by as much as 100 per cent. At high inductions the measured magnetizing force is usually too low by an error which may be as great as 25 per cent. With care, however, and the use of proper correction curves, the apparatus is capable of yielding quanti-

[1] Detailed paper to appear in the Bulletin of the Bureau of Standards.

tive normal induction data in which the error in the magnetizing force is not greater than 5 per cent.

Uncorrected hysteresis data for hard steels show values of the residual induction that are too small by an error which may be as much as 10 per cent, while the coercive forces are too large by an error which may be as much as 40 per cent.

The chief value of such an instrument is for comparative work in which it is desired to determine the degree of uniformity of material or the relative values of similar materials.

PHYSICS.—*The insulating properties of solid dielectrics.*[1] HARVEY L. CURTIS, Bureau of Standards.

Two properties of dielectrics are considered: (1) the volume resistivity and (2) the surface resistivity. The volume resistivity of a material is the resistance in ohms between two opposite faces of a centimeter cube. The surface resistivity is defined as the resistance between two opposite edges of a centimeter square of the surface film which is deposited upon the material.

In measuring the volume resistivity, mercury electrodes were employed in order to make good contact, and a guard-ring was used to prevent any errors on account of surface leakage. The effects of the temperature of the specimen, of the humidity of the surrounding air, and of the magnitude and length of application of the applied voltage were studied. The only one of these which, for ordinary laboratory conditions, affects the order of magnitude of the results is the length of application of the voltage, and this is of importance only if the volume resistivity is greater than 10^{13}. Values of the volume resistivity are given in Table I.

Since the surface resistivity depends upon the surface film any condition which will affect this film will affect the surface resistivity. Upon the surface of all insulators except the waxy materials a film of moisture collects from the surrounding air. The thickness and conductivity of this film depends upon the material of which the insulator is composed and upon the relative

[1] Detailed paper to appear in the Bureau of Standards Bulletin.

TABLE 1

VOLUME RESISTIVITY OF SOLID DIELECTRICS

(Materials arranged in order of decreasing resistivity)

Material	*Resistivity ohm-cm.*	*Material*	*Resistivity ohm-cm.*
Special Paraffin	over 5000×10^{15}	Paraffined Mahogany	40×10^{12}
Ceresin	over 5000×10^{15}	Stabalite	30×10^{12}
Fused Quartz	over 5000×10^{15}	Plate Glass	20×10^{12}
Hard Rubber	1000×10^{15}	Hallowax No. 1001	20×10^{12}
Clear Mica	200×10^{15}	Dielectrite	5×10^{12}
*Sulphur	100×10^{15}	Bakelite No. 5199 RGRB	5×10^{12}
*Amberite	50×10^{15}	Bakelite No. 150	4×10^{12}
*Rosin	50×10^{15}	Gummon	3×10^{12}
*Mica (India ruby slightly stained)	50×10^{15}	Tegit	2×10^{12}
G. E. No. 55 R	40×10^{15}	Opal glass	1×10^{12}
Hallowax No. 5055 B	20×10^{15}	Paraffined Poplar	500×10^{9}
Mica (Brown African clear)	20×10^{15}	Bakelite No. G5200 RGR	400×10^{9}
Bakelite L558	20×10^{15}	Paraffined Maple	300×10^{9}
*Electrose No. 8	20×10^{15}	Bakelite No. 1	200×10^{9}
*Parowax (paraffin)	10×10^{15}	Bakelite No. 190	100×10^{9}
Glyptol	10×10^{15}	Italian Marble	100×10^{9}
*Shellac	10×10^{15}	Bakelite Micarta	50×10^{9}
Kavalier Glass	8×10^{15}	Bakelite No. G 5074	40×10^{9}
*Insulate No 2	8×10^{15}	Black Condensite	40×10^{9}
*Sealing Wax	8×10^{15}	Yellow Condensite	40×10^{9}
*Yellow Electrose	5×10^{15}	Vulcabeston	20×10^{9}
*Duranoid	3×10^{15}	White Celluloid	20×10^{9}
*Murdock No. 100	3×10^{15}	Hard fiber	20×10^{9}
*Yellow Beeswax	2×10^{15}	Black Galalith	20×10^{9}
Khotinsky Cement	2×10^{15}	Lavite	20×10^{9}
*G. E. No. 40	1×10^{15}	White Galalith	10×10^{9}
*G. E. No. 55A	1×10^{15}	Hemit	10×10^{9}
*Moulded Mica	1×10^{15}	Red Fiber	5×10^{9}
		Marble Pink Tenn	5×10^{9}
Unglazed Porcelain	300×10^{12}	Marble Blue Vermont	1×10^{9}
Redmonite (157,4)	200×10^{12}	Ivory	200×10^{6}
Black Electrose	100×10^{12}	Slate	100×10^{6}
Tetrachlornaphthalene	50×10^{12}	Bakelite No 140	20×10^{6}
Mica (India ruby stained)	50×10^{12}		
German Glass	50×10^{12}		

* Apparent resistivity taken after the voltage had been applied for fifteen minutes.

humidity of the surrounding air. For some materials the surface resistance at 1 per cent humidity is 10^{11} times larger than at 95 per cent humidity, though for the majority of materials the surface resistance does not change by a factor of more than 10^6 under these conditions. Since the change is not uniform it has been found necessary to construct curves showing the change of surface resistivity with humidity.

PHYSICAL CHEMISTRY.—*The thermal dehydration of stilbite, thaumasite, and the hydrates of magnesium sulphate and of copper sulphate.* H. E. MERWIN. Geophysical Laboratory.

The method of removing from substances the water which comes off readily only at high temperatures, as outlined in the study of metahewettite,[1] is here applied to a part of the water which is lost readily at ordinary temperatures. About 0.5 gram of material, powdered to pass 40-to-60 mesh, is held in a thin layer between an outer 5-inch test tube and an inner, inverted, 3-inch test tube, the bottom of the latter having been drawn out and having a small opening. The combination is immersed nearly to the top in an oil or nitrate bath, heated to the temperature and for the time desired, and weighed. The immediate object is to determine the rate of loss of water as the temperature is gradually increased. Breaks in the rate should represent definite hydrates if such exist, provided such hydrates have sufficiently differing vapor pressures at the temperatures considered. Some characteristic breaks are shown in figure 1. Temperature is plotted in one direction and in the other either the number of molecules of water to one molecule of anhydrous salt or the percentage loss in weight. The circles or the shapes of the closed areas represent the rate of dehydration. The diameter of a circle is proportional to the amount of water lost during the last heating divided by the time of heating. In cases where the circles overlapped considerably they were replaced by two continuous lines through the ends of each diameter normal to the curve. The periods of heating were 5 minutes.

[1] Hillebrand, Merwin and Wright, Am. Phil. Soc. Proc., **53**: 45. 1914.

$CuSO_4.5H_2O$ (Fig. 1, *B*) loses 2 and 2 molecules of water readily and then 1 molecule at a much higher temperature. At 25° the vapor pressure at which both the 5- and the 3-hydrates can exist is about 7 mm. of mercury; and the 3- and 1-hydrates, about 4.7 mm.; for the 1- and 0-hydrates, about 0.8 mm.[2]

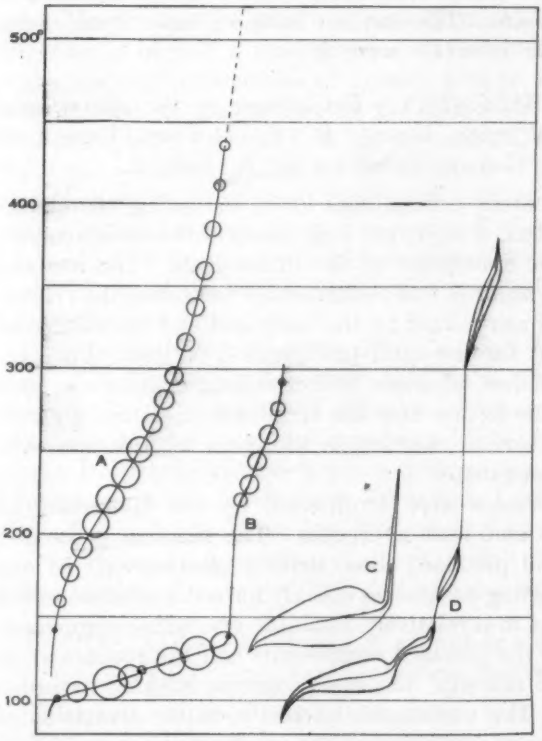

Fig. 1

Stilbite (fig. 1, *A*) loses water continuously without the least evidence of a break. Ten-minute periods of heating gave a curve of the same general shape slightly below this one. The total loss on ignition was 17.6 per cent.

$MgSO_4.7H_2O$ (fig. 1, *D*) shows four distinct periods of maximum evolution of water; the last three represent one molecule each. The first one, during which 4 molecules of water were lost, may indicate the decomposition of the 7-hydrate direct to the 3-hydrate; or intermediate hydrates which decompose immediately may be formed. Such intermediate hydrates, all having about the same vapor pressure, are

[2] Foote, H. W., and Scholes, S. R., Journ. Am. Chem. Soc., **33**: 1324.

known at lower temperatures.[1] The 2- and the 3-hydrates have not been known before, I believe. The temperature intervals were 4°, below 152°; 10°, between 152° and 212°; and 20°, above 212°.

Thaumasite, $CaSO_4.CaCO_3.CaSiO_3.15H_2O$ (fig. 1, *C*). Fourteen molecules of water are expelled much like the first 4 of magnesium sulphate. The last one is much more firmly held. The temperature intervals were 3°.

PHYSICAL CHEMISTRY.—*Equilibrium in the system: lead acetate, lead oxide, water.*[2] R. F. JACKSON, Bureau of Standards. Communicated by G. K. Burgess.

In order to obtain a firm basis for investigating the clarification of raw sugar, a study has been made of the basic acetates of lead from the standpoint of the Phase Rule. The analysis of the basic lead acetates was performed by measuring the volume of standard acid neutralized by the basic lead and the volume of reagent required for the total precipitation of lead. For precipitating lead either sulphuric acid or sodium oxalate was used in excess. In the former case the excess was measured by precipitation with barium chloride, in the latter by titration with potassium permanganate.

The basic acetates were synthesized by the interaction of neutral acetate and lead hydroxide. The reaction proceeded very rapidly and produced some striking phenomena. In one instance the reacting substances quickly formed a solution which rapidly solidified to a relatively insoluble crystalline compound. In another case the unmixed components had the appearance of nearly dry solid material, but upon vigorous shaking formed a mobile liquid. The explanation of this is in the formation of a very soluble basic compound. The equilibria were established by at least 48 hours' agitation at constant temperature. The solid phases capable of existence are as follows:

Neutral lead acetate $Pb(C_2H_3O_2)_2 . 3\ H_2O$ consists of brilliant monoclinic prisms. It is stable in equilibrium with solutions of itself and its solubility increases very rapidly in solutions of

[1] See Foote and Scholes, loc. cit.

[2] Detailed paper to be published in the Bureau of Standards Bulletin.

increasing basicity. Its saturation curve is continuous with that extending into acid solutions. The solubility of the neutral acetate in neutral solutions is 35.50 per cent. The extreme basic solution in equilibrium with the neutral acetate contains 15.89 per cent PbO and 48.95 per cent $Pb(C_2H_3O_2)_2$.

The tetra-lead-monoxy-hexa-acetate $3\ Pb(C_2H_3O_2)_2.PbO.3H_2O$ crystallizes in needles which are usually minute, but may attain the length of half a centimeter. It is exceedingly soluble in water and forms solutions of density 1.93 to 2.28. The solutions contain at the extremes of the saturation curve 15.89 per cent PbO, 48.95 per cent $Pb(C_2H_3O_2)_2$ and 24.74 per cent PbO, 49.21 per cent $Pb(C_2H_3O_2)_2$. The substance is unstable in contact with solutions of itself, but for its existence in equilibrium with a solution it depends upon an excess of dissolved basic lead. On account of the small size and softness of the crystals and the high density of the mother liquor it is practically impossible to isolate the pure substance.

The tri-lead-dioxy-diacetate $Pb(C_2H_3O_2)_2.2\ PbO.4\cdot H_2O$ consists of ill-formed needles which may be so small as to seem amorphous. It is capable of existence in contact with solutions of itself but under such conditions has a solubility of but 13.3 per cent. Its saturation curve however possesses a very great length. The extremes of solubility are 7.4 per cent PbO 4.8 per cent $Pb(C_2H_3O_2)_2$ and 24.74 per cent PbO, 49.21 per cent $Pb(C_2H_3O_2)_2$.

Lead hydroxide is stable in equilibrium with solutions containing as much as 7.4 per cent PbO and 4.8 per cent $Pb(C_2H_3O_2)_2$.

MINERALOGY.—*The identity of empressite with muthmannite.* WALDEMAR T. SCHALLER, Geological Survey.

The name empressite has been given[1] to a silver telluride, AgTe, from Colorado. A consideration of the data given does not seem to justify its specific separation from the earlier described muthmannite.[2]

[1] Bradley, W. M., Empressite, a new silver-tellurium mineral from Colorado. Amer. Jour. Sci. (4), **38**: 163. 1914.

[2] Zambonini, F., Über den Muthmannit, ein neues Mineral, Zeitschr. Kryst. Min., **49**: 246. 1911.

Empressite is "massive in structure, careful inquiries having failed to locate any material showing crystal faces. The mineral occurs in very fine granular and compact masses associated with galena and native tellurium." Its properties could therefore be only partly determined. The following compilation of the pubished properties of empressite and muthmannite shows their relationship.

	EMPRESSITE	MUTHMANNITE
Structure	Massive	Platy elongated crystals, not measurable
Color	Pale bronze[1]	Very light brass yellow[2] to grayish white[3]
Streak	Grayish black to black	Iron gray.
Cleavage	Not determined	Good, parallel elongation
Hardness	3. – 3.5	2 – 2+
Solubility	Readily sol. in hot dilute HNO_3	Decomposed by HNO_3, gold separating
Formula	AgTe	(Ag, Au)Te

1. On fracture surfaces.
2. On the exposed surface.
3. On fresh cleavage surfaces.

All three analyses of muthmannite, as given by Zambonini, show considerable gold, but *in every one the silver predominates molecularly*. In Zambonini's analysis, the ratio of gold to silver is 116 to 244; the gold forms less than one-third of the bases.

The following are the published analyses of muthmannite, the last three being quoted by Zambonini.

ANALYSES OF MUTHMANNITE

LOCALITY	"EMPRESSITE" COLORADO	NAGYAG?	NAGYAG	NAGYAG
Analyst	Bradley	Zambonini	Schrauf	Scharizer
Ag	45.17	26.36	21.0	19.44
Au		22.90	31.0	34.97
Fe	0.22	trace		
Pb		2.58		
Cu		trace		
Insol	0.39			
Te	54.75	46.44	48.0	45.59
	100.53	98.28	100.0	100.00

The analytical figures do not express the relationships as clearly as the molecular ratios which are therefore reproduced below:

RATIOS OF MUTHMANNITE ANALYSES

	BRADLEY	ZAMBONINI	SCHRAUF	SCHARIZER
Te	1.00	1.00	1.00	1.00
Ag	0.97	0.67	0.52	0.50
Au	0.00	0.32	0.42	0.49
(Ag + Au)	0.97	1.02	0.94	0.99

[1] Includes 0.03 Pb.

The ratio of Te to (Ag + Au) is 1 : 1 in all four analyses, and the silver also predominates over the gold in all four analyses. The mineral described as empressite is therefore a pure muthmannite, whereas the other three minerals analyzed are muthmannite with gold replacing part of the silver: they can be more accurately described as auric muthmannite.

ECONOMICS.—*An objective standard of value—Correction and addendum.*—ALFRED J. LOTKA. Communicated by G. K. BURGESS.

In the paper on this subject published in the issue of this Journal dated August 19, 1914, the following changes should be made:

Page 413, in the first line of the paragraph following equation (6), for "The ophelimities Ω_1, Ω_2 . . ." read: "The marginal ophelimities ω_1, ω_2 . . ."

In the fourth line of the same paragraph, for "the ophelimities" read: "the marginal ophelimities."

Page 416, equation (13), for $\mathbf{v}''_2$ read $\mathbf{v}'_2$.

Page 417, in the proportion (18), for $\mathbf{v}'_1\ \mathbf{v}'_2$ read $\mathbf{v}'_1 : \mathbf{v}'_2$.

Page 417. The method by which the proportion (18) is derived from equations (11) and (14) is inadequate.

This proportion (18) follows by an application of the theory of exchange, coupled with the principle introduced in this paper, namely, that in a community in which the sense of value were

perfect, economic activities and transactions, such as exchange upon the market, would be conducted in such manner as to make the rate of increase per head, r, of the community a maximum.

In these circumstances, if $m_1, m_2, \ldots f_1, f_2, \ldots$ are the quantities of the commodities $A_1, A_2, \ldots F_1, F_2, \ldots$ consumed by a representative individual per unit of time, we must have

$$\frac{\partial r}{\partial m_1} dm_1 + \frac{\partial r}{\partial m_2} dm_2 + \ldots + \frac{\partial r}{\partial f_1} df_1 + \frac{\partial r}{\partial f_2} df_2 + \ldots = 0 \quad \text{(I)}$$

for all values of $dm_1, dm_2, \ldots df_1, df_2, \ldots$ compatible with the equations of exchange

$$\left.\begin{aligned} dm_1 &= d\mu_2 + d\mu_3 + \ldots + d\varphi_1 + d\varphi_2 + \ldots \\ \mathfrak{v}_2\, dm_2 &= -\mathfrak{v}_1\, d\mu_2 \\ \mathfrak{v}_3\, dm_3 &= -\mathfrak{v}_1\, d\mu_3 \\ &\ldots \\ \mathfrak{v}'_1\, df_1 &= -\mathfrak{v}_1\, d\varphi_1 \\ \mathfrak{v}'_2\, df_2 &= -\mathfrak{v}_1\, d\varphi_2 \\ &\ldots \end{aligned}\right\} \quad \text{(II)}$$

where $d\mu_2$ is the quantity of A_1 taken in exchange for A_2

$d\mu_3$ is the quantity of A_1 taken in exchange for A_3

. . . . . .

$d\varphi_1$ is the quantity of A_1 taken in exchange for F_1

etc., etc.

By (I) and (II) we then have

$$\left.\begin{aligned} &\frac{\partial r}{\partial m_1}(d\mu_2 + d\mu_3 + \ldots + d\varphi_1 + d\varphi_2 + \ldots) - \frac{\partial r}{\partial m_2}\frac{\mathfrak{v}_1}{\mathfrak{v}_2} d\mu_2 \\ &- \frac{\partial r}{\partial m_3}\frac{\mathfrak{v}_1}{\mathfrak{v}_3} d\mu_3 - \ldots - \frac{\partial r}{\partial f_1}\frac{\mathfrak{v}_1}{\mathfrak{v}'_1} d\varphi_1 - \frac{\partial r}{\partial f_2}\frac{\mathfrak{v}_1}{\mathfrak{v}'_2} d\varphi_2 - \ldots = 0 \end{aligned}\right\} \quad \text{(III)}$$

This relation must hold for all arbitrary values of the infinitesimals $d\mu_2, d\mu_3, \ldots d\varphi_1, d\varphi_2, \ldots$

It follows that

$$\mathfrak{v}_1 : \mathfrak{v}_2 : \ldots : \mathfrak{v}'_1 : \mathfrak{v}'_2 : \ldots : \frac{\partial r}{\partial m_1} : \frac{\partial r}{\partial m_2} : \ldots \frac{\partial r}{\partial f_1} : \frac{\partial r}{\partial f_2} : \ldots \quad (18)$$

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this journal and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

BOTANY.—*Discussion of chemical analysis in distinguishing Jeffrey pine.* W. H. LAMB. Proceedings of the Society of American Foresters, **9**: 338–341. 1914.

This is a discussion in connection with a paper by C. Stowell Smith on "Turpentine Possibilities on the Pacific Coast," in which the occurrence of heptane or abietine in Jeffrey pine (*Pinus jeffreyi*), and turpene in western yellow pine (*Pinus ponderosa*) is pointed out as a means of distinguishing these two closely related trees, since heptane differs materially in its properties from turpene, which is the principal constituent of the more commonly known turpentine oils. Conescale and leaf differences are discussed, illustrated, and correlated with chemical evidences in establishing Jeffrey pine as a distinct species.

W. H. L.

FORESTRY.—*Effect of varying certain cooking conditions in producing soda pulp from aspen.* HENRY E. SURFACE. Bulletin of the U. S. Department of Agriculture, **80**: 1914. Pp. 63.

Experiments were made with aspen (*Populus tremuloides*) by the soda process of paper manufacture to determine what effect the varying of individual cooking conditions would have upon the yield and properties of the pulp and the consumption of cooking chemicals. The cooking conditions investigated were: (1) amount of caustic soda per pound of wood, (2) duration of cooking at maximum temperature, (3) maximum temperature (pressure) of cooking, and (4) initial concentration of the cooking chemicals. In each of the four series of tests all the conditions were held as nearly constant as possible except the one under investigation, which was varied in successive tests or "cooks" according to a definite plan.

It was found that the four conditions of cooking named influenced the yield and properties of the pulp by influencing the severity of the cooking reactions. Severity of cooking is an effect mainly of the amount of caustic soda consumed per unit of wood. Increasing the amount of concentration of the chemical or the pressure of cooking produces a quicker reaction and hence one more complete in a given length of time. Increasing the duration results in a more complete reaction because of the longer time allowed for the available caustic soda to be consumed. Greater severity of cooking is accompanied by a decrease in the yield of crude pulp, and usually of screened pulp unless screenings are present in considerable quantity. The decreased yields obtained on more severe cooking result in a greater cost of wood and soda ash per ton of pulp. As a rule, the small cost of bleaching powder incident to the more easily bleached pulp produced by thorough cooking only partially offsets the greater cost of soda ash and wood. While the amount of bleach required decreases with an increase in the severity of cooking, a point is soon reached where the decrease in bleach is not commensurate with that in yield. Increasing the initial amount of digester liquid increases the condensation and steam consumption (and hence the cost) because of the greater volume to be heated; increasing either the duration or pressure has a similar effect because of the greater losses of heat by radiation. Yields (bone-dry basis) of well-separated, unbleached pulps as high as 56 or 58 pounds per hundred pounds of wood can be obtained from aspen if the wood is of the best quality. Yields of from 54 to 55 per cent were obtained which required only from 10 to 11 per cent of bleach. Yields under different cooking conditions varied from 46 to 58 pounds per hundred pounds of wood, or about 26 per cent. Aspen may be successfully cooked with total durations of from 3 to 4 hours, and with from 20 to 25 pounds of caustic soda charged per hundred pounds of wood, provided the other cooking conditions are properly maintained.

FINDLEY BURNS.

FORESTRY.—*Suitability of longleaf pine for paper pulp.* HENRY E. SURFACE and ROBERT E. COOPER. Bulletin of the U. S. Department of Agriculture, **72**: 1914. Pp. 26.

The recent development in Europe of the sulphate process of paper making, and the superior quality of the product made from resinous woods, has turned attention to longleaf and other Southern pines as a possible source of pulp in this country. These pines have long, thick-walled fibers, and also high specific gravities, implying large yields per

cord. The principal product of the sulphate process is an undercooked, non-bleaching brown pulp, known as "kraft" pulp, which produces a remarkably strong paper, very resistant to wear. The waste wood from the lumber industry in the South suggests a source of cheap raw material.

Tests were made on longleaf pine (*Pinus palustris*). These tests were of two kinds: (1) autoclave tests, comprising several series of cooks made to determine the effects of varying the cooking conditions in the sulphate process, and (2) semi-commercial tests, including cooks made by both the sulphate and soda processes, in the first process employing such cooking conditions as the autoclave tests indicated would give good results, and in the second employing cooking conditions that would give results comparable with those obtained from the sulphate cooks.

The experiments, while not complete, show conclusively (1) that longleaf pine is well adapted for the manufacture of natural-color kraft pulps and papers; (2) that the sulphate process of paper making applied to this wood affords products of better quality and of higher yields than does the soda process; (3) that kraft papers can be made from longleaf pine equal or superior in quality to the imported and domestic kraft papers now on the market; and (4) that the high specific gravity of the wood and the resultant high yield of pulp per cord give longleaf pine an advantage possessed by few, if any, other commercially important woods suitable for pulp making. The autoclave tests indicate that there should be a certain combination of values for the variable cooking conditions which will result in the most economical method of operation.

FINDLEY BURNS.

FORESTRY.—*Balsam fir.* RAPHAEL ZON. Bulletin of the U. S. Department of Agriculture, **55**: 1914. Pp. 68, with plates and text figures.

Balsam fir (*Abies balsamea*) has become commercially important during the last 20 years through the enormous expansion of the pulp industry and the increase in the price of spruce. It constitutes numerically about 20 per cent of the coniferous forests in northern New York and Maine, and is abundant in many parts of New Hampshire, Vermont, northern Michigan, northern Wisconsin, and Minnesota. Wherever it grows it is closely associated with spruce, the two species almost constantly contesting for occupancy of the ground. Under present methods of lumbering, however, balsam fir is increasing at the expense of spruce in the second-growth throughout the entire range of the two species. Balsam fir, while to some extent inferior to spruce as construc-

tion material, has a definite place in the pulp and lumber industries. The inferiority of pulp containing a large amount of balsam is probably not altogether due to the inferiority of the balsam wood, but to deficient knowledge of how properly to manufacture it into paper. The tree grows much faster throughout its entire life than spruce, but is shorter lived and reaches maturity long before the latter. Virgin balsam should be cut at an age of from 100 to 125 years, while spruce, as it grows at present in the wild woods, should be cut at an age of from 175 to 200 years. The best silvicultural system of cutting is that of selection cutting in small groups. Under this system the natural reproduction of both spruce and balsam fir is assured, with the possibility of increasing the proportion of spruce in the new stand.

FINDLEY BURNS.

BACTERIOLOGY.—*Ability of Streptococci to survive pasteurization.* S. HENRY AYERS and W. T. JOHNSON, JR. Journal of Agricultural Research, **2**: 321–330. July 15, 1914.

The thermal death-points of 139 cultures of Streptococci isolated from cow feces, from the udder and mouth of the cow, and from milk and cream, showed a wide variation when heated in tubes of milk for 30 minutes.

At 60°C. (140°F.), the lowest pasteurizing temperature, 89 cultures or 64.03 per cent survived; at 62.8°C. (145°F.), the usual pasteurizing temperature, 46 or 33.07 per cent survived; and at 71.1°C. (160°F.) 2.58 per cent of the cultures survived; all were destroyed at 73.9°C. (165°F.).

The streptococci from the udder were, on the whole, less resistant and those from milk and cream more resistant to heat than those from the mouth of the cow and from cow feces.

Among the 139 cultures of Streptococci there were 22 that formed long chains, which, for the purposes of the paper, were considered as typical Streptococci. The others were considered atypical. The typical Streptococci were much less resistant to heat than were the atypical.

This work indicates that two classes of Streptococci survive pasteurization: (a) Streptococci which have a low majority thermal death-point, but among which a few cells are able to survive the pasteurizing temperature; (b) Streptococci which have a high majority thermal death-point. In the latter case the bacteria survive because the majority thermal death-point is above the temperature used in pasteurization. This ability to resist destruction by heating is a permanent characteristic of certain strains of Streptococci.

S. H. A.

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